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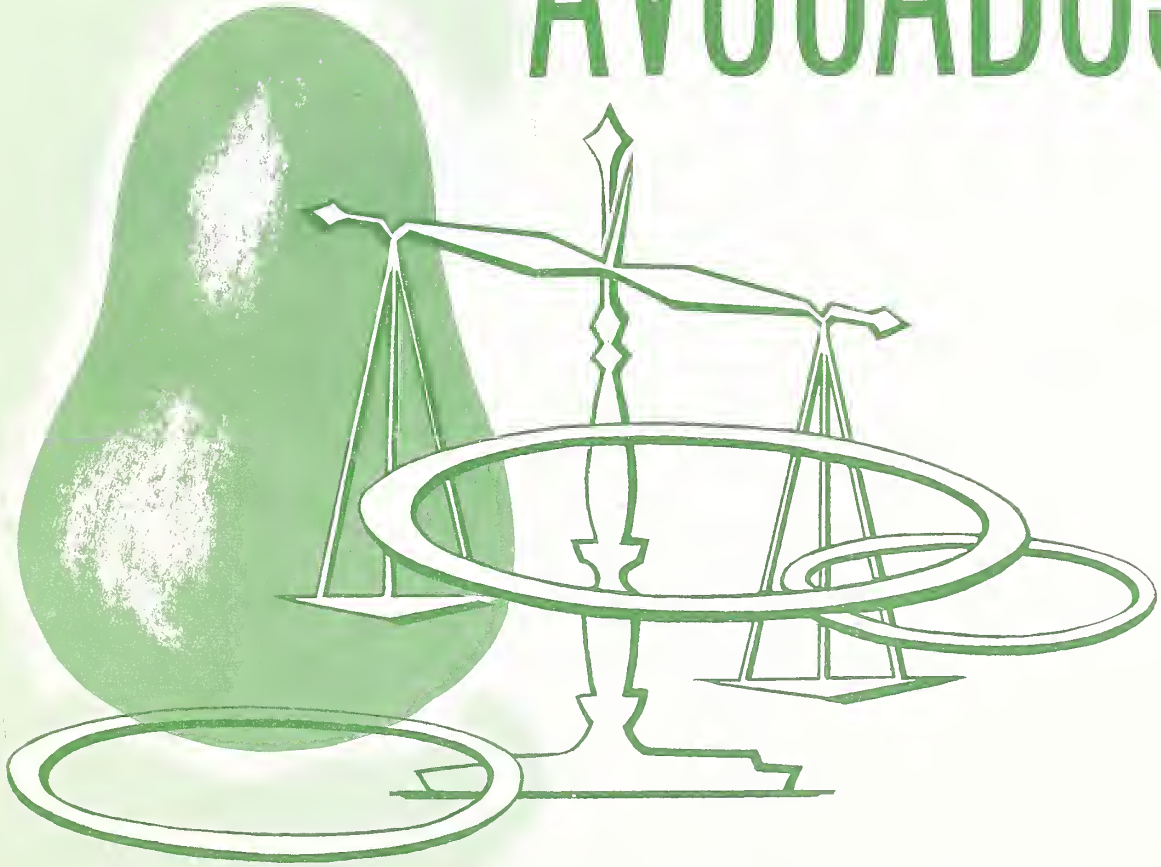
FRUIT WEIGHTS and CORRESPONDING DIAMETERS for

FLORIDA AVOCADOS



U. S. DEPARTMENT OF AGRICULTURE
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Market Quality Research Division

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Washington, D. C. October 1963

SUMMARY

The Florida avocado industry regulates the commercial shipment of avocados by means of a Federal Marketing Agreement program. Specifications under the agreement include minimum fruit weights or fruit diameters.

Avocados of 39 varieties were individually weighed and measured with graduated rings for diameter, and the findings are listed, showing fruit weights with the corresponding average diameters. A standard deviation of ± 1/16 inch in diameter existed at all given fruit weights. During a three-season period, it was found, based on the method of orthogonal polynomials, that average fruit weights and corresponding diameters were similar in Waldin and Booth 1 avocados. These factors were also similar in Pollock, Booth 8, Lula, and Taylor avocados.

FRUIT WEIGHTS AND CORRESPONDING DIAMETERS FOR FLORIDA AVOCADOS

T. T. Hatton, Jr., P. L. Harding, W. F. Reeder, John N. Yeatman, and W. H. Krome[1]

Market Quality Research Division
Agricultural Marketing Service

INTRODUCTION

Maturity standards for the shipment of Florida avocados are based on minimum weights and/or diameters which fruit must attain by designated shipping dates for each variety. The basis for these specifications was established in 1954 in a Federal Marketing Agreement and Order.[2] The specifications permit the larger sizes of some varieties to be shipped on initial shipping dates, and as the season progresses, the weight and diameter restrictions are gradually lowered and eventually removed. Other varieties are subject to weight and diameter restrictions at an initial shipping date; for these varieties this is the only restriction, and it is removed later in the season. Several minor varieties are not subject to size restrictions, but merely to an initial shipping date.

Growers use diameter standards when harvesting fruit. Packinghouses usually use weight standards for sizing fruit. The purpose of this work was to provide an available reference to be used to determine the diameter that might be expected for a given fruit weight.

MATERIALS AND METHODS

More than 15,000 avocados of 39 varieties were individually weighed and measured for diameter from 1954 through 1962. Various numbers of fruit were used for each weight and diameter determination; usually fewer fruits of extreme large and small sizes were available than were intermediate sizes. All avocados were obtained from groves in Dade County, except Taylor avocados, which were obtained from Palm Beach and Highlands Counties as well as Dade County.

A detailed study was made of Pollock, Waldin, Booth 8, Lula, Taylor, and Booth 1 varieties for the 3 crop years, 1958-59 to 1960-61. Seven biweekly pickings were made each year and at each picking 12 fruits were obtained from each of 3 groves. Whenever possible the same groves and trees were sampled throughout the 3-year period.

Weight measurements were made to the nearest 1/20 ounce. Diameter measurements were made by rings graduated in sizes of 1/16 inch. Only freshly picked, firm avocados were used.

A range of fruit weights was listed for each variety and the corresponding average diameter was assigned to each weight. Fruit weights are shown in ounces. Any fruit weighing a fraction of an ounce more than the listed weight would still be represented by a whole number; avocados weighing from 16 to 17 ounces, but not including 17 ounces, were listed as 16 ounces in weight. The 17-ounce listing was used only if the avocado weighed at least 17.0 ounces. Standard deviations were computed to determine the range in diameter that could be predicted for each fruit weight.

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[1] T. T. Hatton, Jr., senior horticulturist; P. L. Harding, research plant physiologist; W. F. Reeder, biological aid; and John N. Yeatman, food technologist, all of the Market Quality Research Division, Agricultural Marketing Service; and W. H. Krome, grower and former chairman of the Maturity Subcommittee of the Florida Avocado Administrative Committee.

[2] U. S. Department of Agriculture, AMS. 1954. Marketing agreement No. 121 and order No. 69 regulating handling. Part 969-Avocados grown in south Florida. (After January 1962 marketing order recodified as number 915).

Data for the six varieties studied in detail during the 3-year period were plotted graphically by employing the orthogonal polynomial method to the second degree.[3]

RESULTS AND DISCUSSION

Data for fruit weights with corresponding diameters for the 39 varieties are in appendix table 1. The listed weights begin below those specified in regulations under the Federal Marketing Agreement and Order and extend above those specified in the regulations.

The correlation between fruit weight and diameter was found to be highly significant (e.g., for the 3-year study, r = 0.949 for Waldin and Booth 1 avocados; r = 0.912 for Pollock, Booth 8, Lula,and Taylor avocados). Varietal relationships of fruit weight and diameter for 3 years are illustrated (fig. 1). Average fruit weights and corresponding diameters were similar in Waldin and Booth 1 avocados. These factors were also similar in Pollock, Booth 8, Lula, and Taylor avocados. The plotted curves (fig. 1) show the difference between the two groups of varieties. The curve that represents the four varieties would not be applicable in the high range of weights, except in the case of Pollock, because Booth 8, Lula, and Taylor never reach the large size of the Pollock.

In several instances the same listed diameter was applicable to two successive fruit weights because the average diameters were expressed only to the nearest 1/16 inch and because, with some of the more elongated varieties, an increase of 1 ounce in weight would result in only a slight increase in the diameter of the fruit. On the other hand, some varieties, which were more oval in shape, showed a marked increase in diameter, sometimes as much as 1/8 inch, with an increase of 1 ounce in weight.

The standard deviation for all of the varieties averaged ± 1/16 inch. At certain weights a few varieties had standard deviations slightly more or slightly less than ± 1/16 inch. The small variations in standard deviations for diameter at a given weight appeared to be associated with the configuration or shape of the avocado. Although misshapen fruit was avoided, some varieties inherently have a range of shapes, while others are more uniform. This difference in configuration of fruit is best exemplified in pear-shaped varieties. Fruits of this shape, with the same weight, usually have smaller diameters, with an elongated neck, than those with short necks.

Table 1 should be a ready reference for members of the Florida avocado industry to use for future adjustments in the shipping schedule of avocado fruit weights and diameters.

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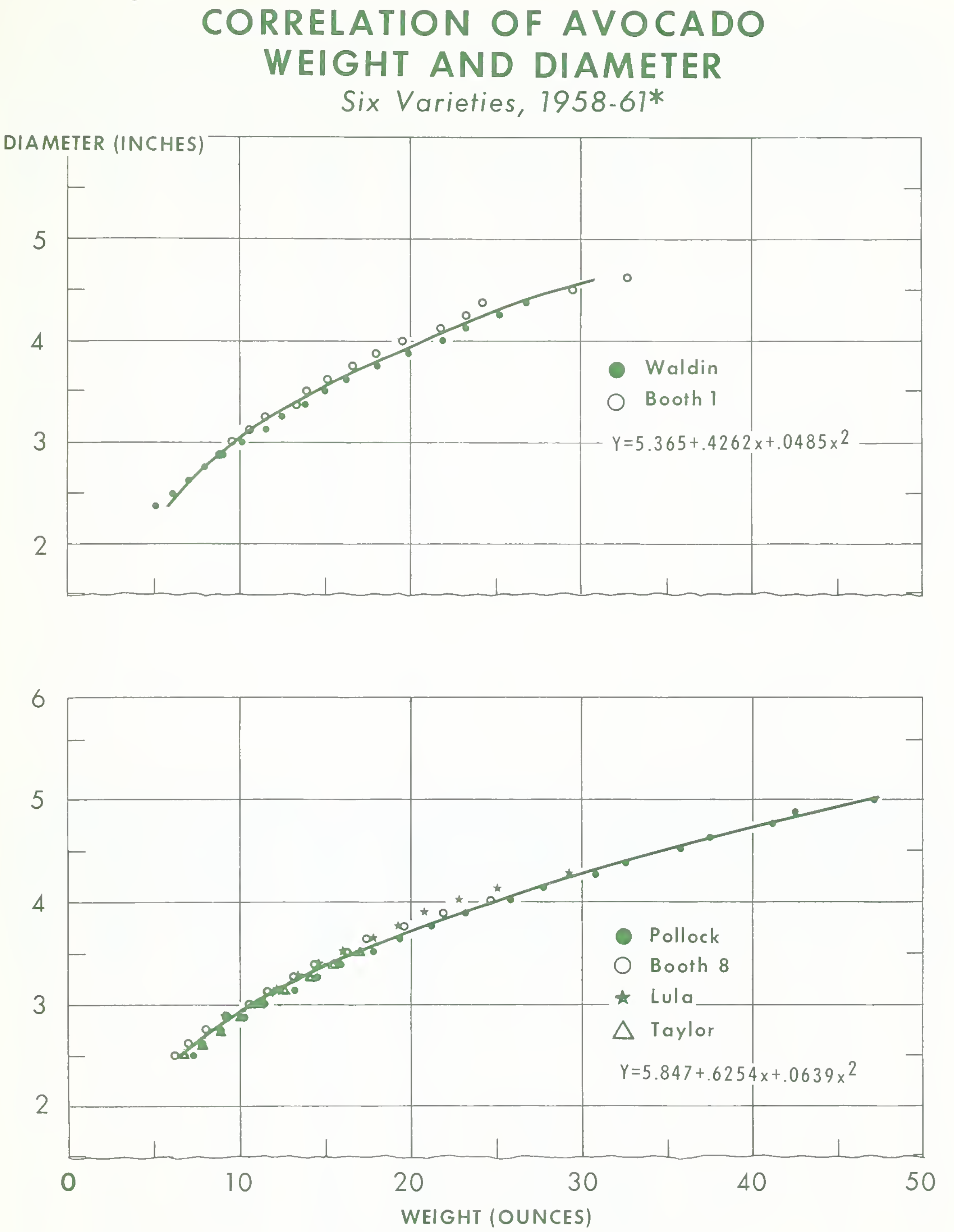
[3] Anderson, R. L. and E. E. Houseman. Tables of Orthogonal Polynomial Values Extended to N = 104. Iowa Agr. Exp. Sta. Res. Bul. 297, pp. 595-672. 1942.



*EACH POINT IS AN AVERAGE OF SEVERAL FRUITS.

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Figure 1. --Correlation of fruit weight and diameter for several varieties of Florida avocados (1958-61)

TABLE 1.--Fruit weights and corresponding diameters for Florida avocado varieties

Ajax (Booth 7B)		Arue		Avon		Black Prince		Blair	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
8	2 15/16	14	3 3/16	6	2 8/16	12	3 2/16	10	3 5/16
9	3	15	3 5/16	7	2 11/16	13	3 3/16	11	3 6/16
10	3 1/16	16	3 7/16	8	2 13/16	14	3 4/16	12	3 7/16
11	3 3/16	17	3 9/16	9	2 14/16	15	3 5/16	13	3 8/16
12	3 5/16	18	3 11/16	10	3	16	3 6/16	14	3 9/16
13	3 7/16	19	3 12/16	11	3 2/16	17	3 8/16	15	3 10/16
14	3 8/16	20	3 13/16	12	3 5/16	18	3 10/16	16	3 12/16
15	3 10/16	21	3 14/16	13	3 7/16	19	3 11/16	17	3 13/16
16	3 11/16	22	3 15/16	14	3 9/16	20	3 12/16	18	3 14/16
17	3 12/16	23	4	15	3 11/16	21	3 13/16		
18	3 14/16	24	4 1/16			22	3 14/16		
19	4					23	3 15/16		
20	4 1/16					24	4		
21	4 2/16								
22	4 3/16								
23	4 4/16								
24	4 5/16								

Booth 1		Booth 3		Booth 5		Booth 7		Booth 8	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
10	3 3/16	8	2 14/16	7	2 14/16	7	2 11/16	7	2 11/16
11	3 5/16	9	3	8	2 15/16	8	2 13/16	8	2 13/16
12	3 6/16	10	3 1/16	9	3 1/16	9	2 15/16	9	2 15/16
13	3 9/16	11	3 3/16	10	3 2/16	10	3 2/16	10	3 1/16
14	3 9/16	12	3 5/16	11	3 4/16	11	3 4/16	11	3 2/16
15	3 11/16	13	3 6/16	12	3 6/16	12	3 5/16	12	3 3/16
16	3 12/16	14	3 7/16	13	3 7/16	13	3 6/16	13	3 4/16
17	3 13/16	15	3 9/16	14	3 8/16	14	3 8/16	14	3 6/16
18	3 15/16	16	3 10/16	15	3 10/16	15	3 8/16	15	3 7/16
19	4	17	3 11/16	16	3 11/16	16	3 10/16	16	3 9/16
20	4 1/16	18	3 12/16	17	3 13/16	17	3 12/16	17	3 10/16
21	4 2/16	19	3 13/16	18	3 14/16	18	3 13/16	18	3 10/16
22	4 3/16	20	3 14/16			19	3 14/16	19	3 12/16
		21	3 15/16			20	3 15/16		
		22	3 15/16						

TABLE 1.--Fruit weights and corresponding diameters for Florida avocado varieties (Continued)

Booth 10		Booth 11		Byars		Choquette		Collinson	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
10	3 4/16	10	3 3/16	14	3 12/16	14	3 7/16	10	3 3/16
11	3 5/16	11	3 5/16	15	3 13/16	15	3 8/16	11	3 4/16
12	3 6/16	12	3 6/16	16	3 14/16	16	3 10/16	12	3 6/16
13	3 7/16	13	3 7/16	17	3 15/16	17	3 11/16	13	3 7/16
14	3 8/16	14	3 9/16	18	3 15/16	18	3 12/16	14	3 8/16
15	3 9/16	15	3 11/16	19	4	19	3 13/16	15	3 9/16
16	3 10/16	16	3 12/16	20	4 1/16	20	3 14/16	16	3 10/16
17	3 12/16	17	3 13/16	21	4 2/16	21	3 14/16	17	3 11/16
18	3 14/16	18	3 14/16	22	4 3/16	22	3 15/16	18	3 12/16
				23	4 4/16	23	4	19	3 14/16
				24	4 5/16	24	4 1/16	20	4
						25	4 2/16	21	4
						26	4 3/16	22	4 1/16
						27	4 3/16		
						28	4 4/16		
						29	4 5/16		
						30	4 6/16		

Fuchs		Hall		Hardee		Herman		Hickson	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
6	2 8/16	14	3 3/16	10	2 12/16	10	3 1/16	8	2 12/16
7	2 9/16	15	3 4/16	11	2 14/16	11	3 2/16	9	2 14/16
8	2 10/16	16	3 4/16	12	2 15/16	12	3 3/16	10	2 15/16
9	2 12/16	17	3 6/16	13	3	13	3 5/16	11	3
10	2 14/16	18	3 8/16	14	3 1/16	14	3 6/16	12	3 1/16
11	2 15/16	19	3 8/16	15	3 2/16	15	3 8/16	13	3 3/16
12	3	20	3 9/16	16	3 3/16	16	3 9/16	14	3 4/16
13	3 2/16	21	3 10/16	17	3 4/16	17	3 10/16	15	3 5/16
14	3 3/16	22	3 10/16	18	3 6/16	18	3 12/16	16	3 6/16
15	3 4/16	23	3 11/16	19	3 6/16			17	3 7/16
16	3 5/16	24	3 12/16	20	3 9/16			18	3 8/16
17	3 6/16	25	3 13/16					19	3 10/16
18	3 8/16	26	3 14/16					20	3 10/16

TABLE 1.--Fruit weights and corresponding diameters for Florida avocado varieties (Continued)

Itzamna		Linda		Lula		Monroe		Nabal	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
6	2 12/16	16	3 10/16	9	2 14/16	14	3 7/16	6	2 11/16
7	2 13/16	17	3 11/16	10	3 1/16	15	3 8/16	7	2 12/16
8	2 14/16	18	3 12/16	11	3 3/16	16	3 10/16	8	2 13/16
9	2 15/16	19	3 13/16	12	3 3/16	17	3 11/16	9	2 15/16
10	3 1/16	20	3 14/16	13	3 5/16	18	3 12/16	10	3 3/16
11	3 2/16	21	3 15/16	14	3 6/16	19	3 13/16	11	3 4/16
12	3 3/16	22	4	15	3 8/16	20	3 14/16	12	3 6/16
13	3 4/16	23	4 1/16	16	3 8/16	21	3 14/16	13	3 8/16
14	3 5/16	24	4 2/16	17	3 9/16	22	3 15/16	14	3 9/16
				18	3 11/16	23	4	15	3 10/16
				19	3 12/16	24	4 1/16	16	3 11/16
				20	3 13/16	25	4 2/16	17	3 12/16
				21	3 14/16	26	4 3/16	18	3 13/16
				22	4	27	4 3/16	19	3 14/16
				23	4 1/16	28	4 4/16		
				24	4 2/16	29	4 5/16		
						30	4 6/16		

Nadir		Petersen		Pinelli		Pollock		Schmidt	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
9	2 13/16	7	2 12/16	12	3 5/16	10	2 15/16	12	3 6/16
10	2 14/16	8	2 14/16	13	3 6/16	11	3	13	3 7/16
11	3	9	3	14	3 8/16	12	3 2/16	14	3 8/16
12	3 1/16	10	3 2/16	15	3 9/16	13	3 4/16	15	3 9/16
13	3 2/16	11	3 4/16	16	3 10/16	14	3 5/16	16	3 10/16
14	3 3/16	12	3 5/16	17	3 11/16	15	3 6/16	17	3 11/16
15	3 5/16	13	3 6/16	18	3 12/16	16	3 7/16	18	3 12/16
16	3 6/16	14	3 8/16	19	3 13/16	17	3 8/16	19	3 13/16
		15	3 9/16	20	3 14/16	18	3 10/16	20	3 14/16
		16	3 12/16			19	3 10/16		
						20	3 11/16		
						21	3 12/16		
						22	3 13/16		
						23	3 14/16		
						24	3 15/16		

TABLE 1.--Fruit weights and corresponding diameters for Florida avocado varieties (Continued)

Simmonds		Simpson		Taylor		Tonnage		Trapp	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
12	3 3/16	12	3 5/16	6	2 9/16	7	2 9/16	9	3 1/16
13	3 4/16	13	3 6/16	7	2 11/16	8	2 10/16	10	3 2/16
14	3 4/16	14	3 7/16	8	2 12/16	9	2 12/16	11	3 4/16
15	3 7/16	15	3 8/16	9	2 14/16	10	2 13/16	12	3 7/16
16	3 7/16	16	3 9/16	10	3	11	2 15/16	13	3 8/16
17	3 8/16	17	3 10/16	11	3 1/16	12	3	14	3 10/16
18	3 10/16	18	3 11/16	12	3 2/16	13	3 2/16	15	3 10/16
19	3 11/16	19	3 12/16	13	3 3/16	14	3 4/16	16	3 11/16
20	3 13/16	20	3 13/16	14	3 5/16	15	3 5/16	17	3 13/16
21	3 13/16			15	3 6/16	16	3 7/16	18	3 15/16
22	3 14/16					17	3 8/16		
						18	3 9/16		

Vaca		Wagner		Waldin		Winslowson	
Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter	Weight	Mean diameter
Ounces	Inches	Ounces	Inches	Ounces	Inches	Ounces	Inches
10	3 1/16	8	2 14/16	6	2 10/16	10	3 3/16
11	3 2/16	9	3 1/16	7	2 12/16	11	3 4/16
12	3 3/16	10	3 2/16	8	2 14/16	12	3 6/16
13	3 5/16	11	3 3/16	9	2 16/16	13	3 8/16
14	3 7/16	12	3 5/16	10	3 1/16	14	3 9/16
15	3 8/16	13	3 6/16	11	3 3/16	15	3 11/16
16	3 9/16	14	3 8/16	12	3 4/16	16	3 12/16
17	3 10/16			13	3 6/16	17	3 13/16
18	3 12/16			14	3 7/16	18	3 14/16
				15	3 9/16		
				16	3 9/16	20	4
				17	3 11/16		
				18	3 13/16		
				19	3 13/16		
				20	3 15/16		
				21	4		